MSM6679 Voice Recognition Processor

SI/SD Voice Recognizer, Recorder/Player, and Speech Synthesizer

Contents

OKI Semiconductor

MSM6679 Voice Recognition Processor

SI/SD Voice Recognizer, Recorder/Player, and Speech Synthesizer

DESCRIPTION

The MSM6679-XXXJS Voice Recognition Processor (VRP) is a slave-mode device that performs five functions: speaker-independent (SI) voice recognition, speaker-dependent (SD) voice recognition, solid-state sound recording, sound playback, and speech synthesis. The highly integrated device also provides an on-chip memory controller, Flash memory interface, analog data conversion, OKI speech synthesizer interface, and PWM sound output.

For SI recognition, the MSM6679 contains a vocabulary template in on-chip or external memory. Pretrained SI vocabularies eliminate the need for laborious training, as usually required by SD products. The memory requirements are dependent on the size of the vocabulary. The MSM6679 can tolerate background noise, while providing high recognition accuracy. In its designated operating environment, the device achieves a typical recognition accuracy of >95% (using an OKI-defined test procedure).

For SD recognition, the MSM6679 stores speaker-dependent vocabulary templates, as defined by the user, in external SRAM. The MSM6679 can create SD vocabularies of up to 61 words each, with each word using approximately 50 bytes.

As well as providing voice recognition capabilities, the MSM6679 integrates a solid-state recorder/player, speech synthesis functions, and a tone generator. ADPCM recording/playback provides high quality sound and efficient memory utilization. The MSM6679 can respond to spoken commands, verbally or with tones, via an on-chip speech synthesizer and tone generator. For larger speech-synthesis requirements, the MSM6679 also provides a glueless MSM665x control interface for off-chip speech synthesis.

The MSM6679 can interface to any application or personal computer via a parallel or serial interface through an open, device-independent serial mode API (SMAPI). To accelerate code development, OKI supplies an evaluation kit, and assembly and C language programs for this product.

FEATURES

- Speaker-independent recognition
  - Up to 20~25 words in each vocabulary
  - Multiple vocabulary support
- Speaker-dependent recognition
  - Up to 61 words in each vocabulary
  - Multiple vocabulary support
- Speech synthesis
  - Up to 2.3sec internal and 27.6sec external speech synthesis on-chip; sample looping and concatenation allows even longer phrases.
  - On-chip controller for MSM665x speech synthesizer
  - Standard beep tone outputs
  - PCM and ADPCM voice or sound-effect output
- Speech capture and playback
  - 28kbps ADPCM speech compression
- Serial ASCII and parallel command interface
- 6944Hz audio input sample rate for record and playback
- 10kHz sample rate for voice recognition
- 200msec recognition latency
- Flexible memory mapping for EPROM, FLASH, and SRAM
- 32MHz operation
- Package: 84-pin PLCC (QFJ84-P-S115)

FUNCTIONAL AND I/O DIAGRAMS

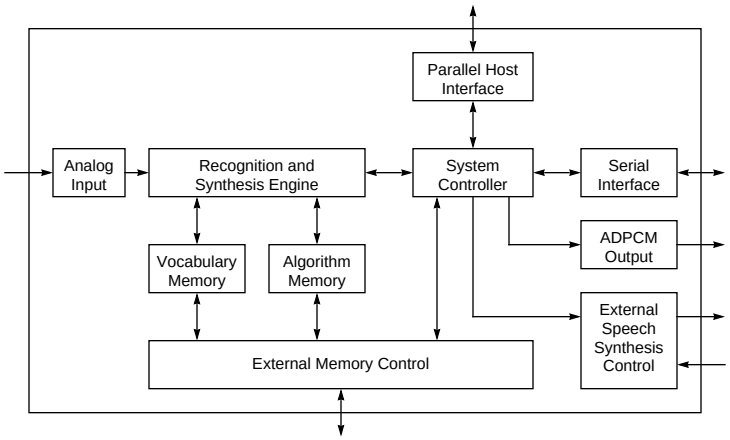

Figure 1. MSM6679 Block Diagram

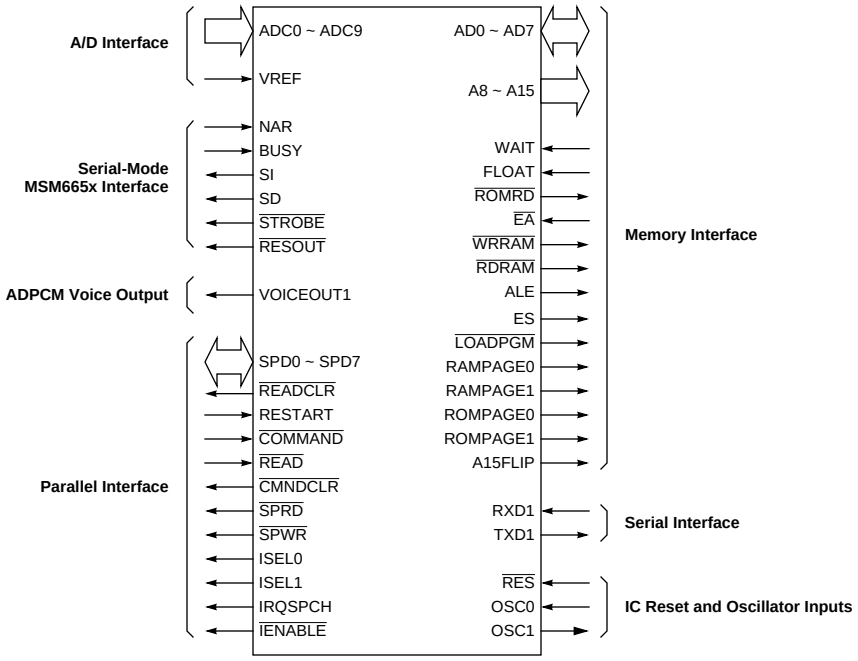

Figure 2. MSM6679 Logic Symbol

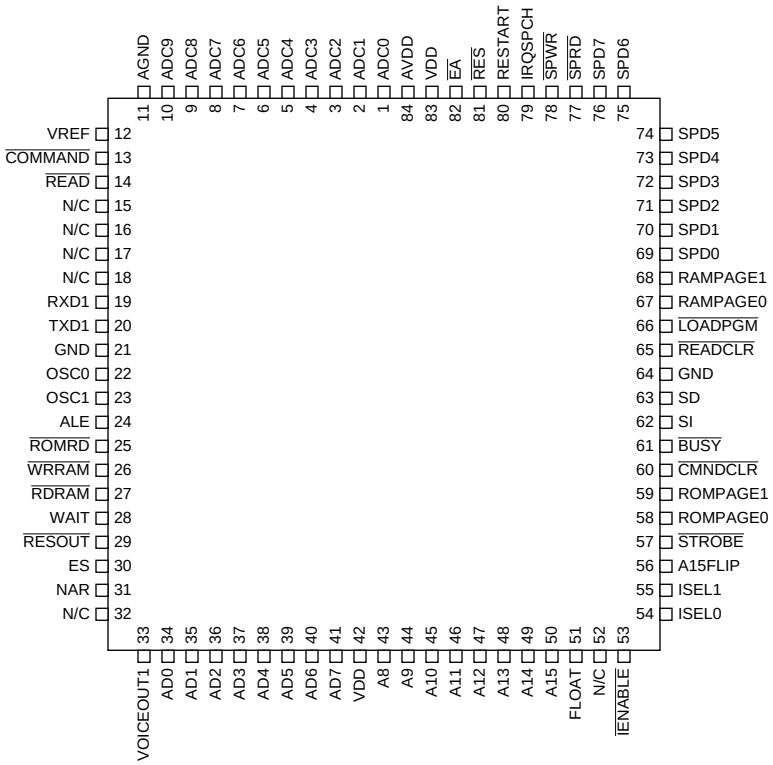

Figure 3. MSM6679 84-Pin PLCC Pinout

MSM6679 Alphabetic Pin List

Name	#	Name	#	Name	#	Name	#	Name	#	Name	#	Name	#
AD0	34	A11	46	ADC5	6	$\overline{EA}$	82	OSC1	23	$\overline{ROMRD}$	25	SPD7	76
AD1	35	A12	47	ADC6	7	ES	30	RAMPAGE0	67	RXD1	19	$\overline{SPRD}$	77
AD2	36	A13	48	ADC7	8	FLOAT	51	RAMPAGE1	68	SD	63	$\overline{SPWR}$	78
AD3	37	A14	49	ADC8	9	GND	21,64	$\overline{RDRAM}$	27	SI	62	$\overline{STROBE}$	57
AD4	38	A15	50	ADC9	10	$\overline{IENABLE}$	53	$\overline{READ}$	14	SPD0	69	TXD1	20
AD5	39	A15FLIP	56	AGND	11	IRQSPCH	79	$\overline{READCLR}$	65	SPD1	70	VREF	12
AD6	40	ADC0	1	ALE	24	ISEL0	54	$\overline{RES}$	81	SPD2	71	VOICEOUT1	33
AD7	41	ADC1	2	AVDD	84	ISEL1	55	$\overline{RESOUT}$	29	SPD3	72	WAIT	28
A8	43	ADC2	3	$\overline{BUSY}$	61	$\overline{LOADPGM}$	66	RESTART	80	SPD4	73	$\overline{WRRAM}$	26
A9	44	ADC3	4	$\overline{CMNDCLR}$	60	NAR	31	ROMPAGE0	58	SPD5	74	VDD	42,83
A10	45	ADC4	5	$\overline{COMMAND}$	13	OSC0	22	ROMPAGE1	59	SPD6	75		

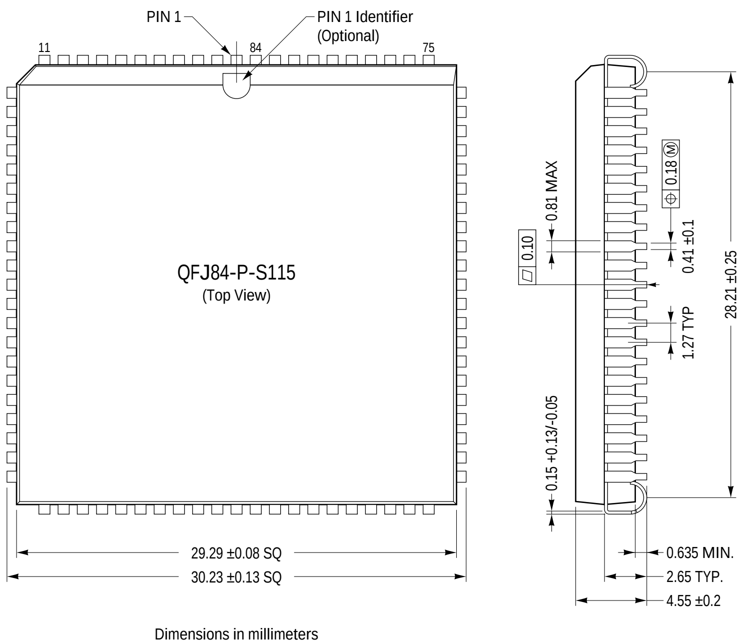

Figure 4. MSM6679 Package Mechanical Drawing

PIN DESCRIPTIONS

Pin #	Pin Name	Signal Type	Description
1	ADC0	Analog input	**Analog Input.** These ten inputs are tied together and serve as the analog input. Signal conditioning, via a bandpass filter and gain circuit, is required before this input.
2	ADC1		
3	ADC2		
4	ADC3		
5	ADC4		
6	ADC5		
7	ADC6		
8	ADC7		
9	ADC8		
10	ADC9		
11	AGND	Analog ground	**Analog Ground.** This pin provides an analog ground point, allowing independent grounding of the analog and digital circuitry. Separate grounds reduce the impact of digital switching noise on analog sampling accuracy.
12	VREF	Reference voltage	**Analog Reference Voltage.** The MSM6679's on-chip A/D converter uses this analog reference voltage when converting an analog signal into digital samples
13	$\overline{\text{COMMAND}}$	Input	**Parallel Interface Command.** This is an interrupt input. When asserted LOW, a command is available at the parallel interface.
14	$\overline{\text{READ}}$	Input	**Host Interrupt Read**. This is an interrupt input. When asserted LOW, the host interface has read the latch.
15	N/C	(not connected)	**Reserved.** These pins are reserved for future use and should be left open.
16	N/C		
17	N/C		
18	N/C		
19	RXD1	Input	**Serial Port Receive**. This is the receive data line for serial port.
20	TXD1	Output	**Serial Port Transmit.** This is the transmit data line for serial port.
21	GND	Ground	**Ground.**
22	OSC0	Input	**Oscillator 0/External Clock.** When the MSM6679 uses a crystal oscillator, this input is the oscillator input pin. The pin is then connected to one side of a crystal and load capacitor. When used with an external clock, the external clock is applied to this input.
23	OSC1	Output	**Oscillator 1.** When the MSM6679 uses a crystal oscillator, this output is the oscillator output pin. The pin is then connected to one side of a crystal and load capacitor. When used with an external clock, this output is left unconnected.
24	ALE	Output	**Memory Address Latch Enable.** An external memory latch is controlled by this signal, the address latch enable output.
25	$\overline{\text{ROMRD}}$	Output	**ROM Read.** This is a strobe signal for direct connection to an external ROM's $\overline{\text{READ}}$ input. When asserted LOW, this signal indicates that the MSM6679 is ready to read data from the ROM.
26	$\overline{\text{WRRAM}}$	Output	**RAM Write.** This is a strobe signal for direct connection to an external RAM's $\overline{\text{WR}}$ input. When asserted LOW, this signal indicates that the MSM6679 is ready to write data to RAM.
27	$\overline{\text{RDRAM}}$	Output	**RAM Read.** This is a strobe signal for direct connection to an external RAM's $\overline{\text{RD}}$ input. When asserted LOW, this signal indicates that the MSM6679 is ready to read data from RAM.
28	WAIT	Input	**Memory Wait.** When tied high, this signal makes the MSM6679 extend the external memory cycle.

Pin #	Pin Name	Signal Type	Description
29	$\overline{\text{RESOUT}}$	Output	**MSM665x Reset.** This pin provides a reset signal for an external speech synthesis engine.
30	ES	Output	**Flash Bank Control (Extended Segments).** This is the control signal for flash memory banking.
31	NAR	Input	**MSM665x Next Address Request.** This pin signals to the MSM6679 that the external speech synthesis engine is ready for another command.
32	N/C	(not connected)	**Reserved.** This pins is reserved for future use and should be left open.
33	VOICEOUT1	Output	**Voice Out.** This pin is the PWM output for speech synthesis, voice sample playback, and voice prompts. An external integrator must be used to convert this to an analog signal.
34	AD0	Bidirectional I/O	**Memory Address/Data Bus.** These are multiplexed address/data lines for the eight data bits and the lower eight address bits (the upper eight address bits are not multiplexed).
35	AD1		
36	AD2		
37	AD3		
38	AD4		
39	AD5		
40	AD6		
41	AD7		
42	VDD	Digital Power	**Power.**
43	A8	Outputs	**Memory Address Bus.** These are the upper eight address pins.
44	A9		
45	A10		
46	A11		
47	A12		
48	A13		
49	A14		
50	A15		
51	FLOAT	Input	**3-State All Outputs.** This signal sets all pins on the device to the high-impedance state.
52	N/C	(Not Connected)	**Reserved.** This pins is reserved for future use and should be left open.
53	$\overline{\text{IENABLE}}$	Output	**Parallel Interface Interrupt Enable.** When asserted low, this signal enables the interrupts for the parallel interface.
54	ISEL0	Outputs	**Interrupt Select**. ISEL0 is the low order bit and ISEL1 is the high-order bit for selecting one of four bit-coded interrupts.
55	ISEL1		
56	A15FLIP	Output	**Memory Address A15 Flip.** This signal inverts the A15 address signal for 32-Kbyte bank switching on the local memory bus.
57	$\overline{\text{STROBE}}$	Output	**MSM665x Strobe.** This output provides the LOAD signal for an external speech synthesizer.
58	ROMPAGE0	Outputs	**ROM Page Select.** These signals select one of four 64-Kbyte ROM pages.
59	ROMPAGE1		
60	$\overline{\text{CMNDCLR}}$	Output	**Command Interrupt Latch Clear.** This is a strobe signal to clear an external command interrupt latch.
61	$\overline{\text{BUSY}}$	Input	**MSM665x Busy.** When using an external MSM665x device, this pin monitors the MSM665x $\overline{\text{BUSY}}$ signal and connects directly to the MSM665x $\overline{\text{BUSY}}$ signal output.
62	SI	Output	**MSM665x Serial Clock.** This MSM6679 output connects to the MSM665x SI input. The SI pin is the MSM665x serial clock input pin.
63	SD	Output	**MSM665x Serial Data.** This MSM6679 output connects to the MSM665x SD input. The SD pin is the MSM665x serial data input pin.

Pin #	Pin Name	Signal Type	Description
64	GND	Digital Ground	**Ground.**
65	$\overline{\text{READCLR}}$	Output	**Read Interrupt Latch Clear.** This strobe signal, when asserted LOW, clears the external read interrupt latch.
66	$\overline{\text{LOADPGM}}$	Output	**Load Program.** This signal allows the MSM6679 to write data to program memory. When asserted low, this signal should set the program memory in write mode.
67	RAMPAGE0	Output	**RAM Page Select.** These signals support selection of one out of four RAM pages. Each page is 64 Kbytes in size.
68	RAMPAGE1		
69	SPD0	Bidirectional	**Parallel Interface Data Bus.** These are the system parallel data bus lines, allowing connection of the MSM6679 to an 8-bit port or 8-bit microcontroller interface.
70	SPD1		
71	SPD2		
72	SPD3		
73	SPD4		
74	SPD5		
75	SPD6		
76	SPD7		
77	$\overline{\text{SPRD}}$	Output	**Parallel Interface Read.** The MSM6679 asserts this signal LOW when it is ready to read data in an external parallel data latch.
78	$\overline{\text{SPWR}}$		**Parallel Interface Write.** The MSM6679 asserts this signal LOW when writing data to an external parallel data latch
79	IRQSPCH	Output	**Parallel Interface Interrupt.** This is an interrupt output signal for the parallel interface.
80	RESTART	Input	**Restart after Loading Program.** This signal is used to restart the MSM6679 after loading external program memory.
81	$\overline{\text{RES}}$	Input	**MSM6679 Reset.** External logic should assert this power-on reset signal low when power is applied to the MSM6679.
82	$\overline{\text{EA}}$	Input	**External ROM Address Select.** This control signal enables external ROM execution. This signal is usually connected to ROMPAGE1 and a pullup resistor.
83	VDD	Positive digital supply	**Power.**
84	AVDD	Analog power supply	**Analog Power.**

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Parameter	Symbol	Conditions [1]	Value	Unit
Digital power supply voltage	V_{DD}	GND = AGND = 0 V	-0.3 to +7.0	V
Input voltage	V_I		-0.3 to V_{DD} +0.3	
Output voltage	V_O		-0.3 to V_{DD} +0.3	
Analog power voltage	AV_{DD}		-0.3 to V_{DD} +0.3	
Analog reference voltage	V_{REF}		-0.3 to AV_{DD} +0.3	
Analog input voltage	VAI		-0.3 to V_{REF}	
Power dissipation	PD	Ta = 85 °C, per package	1300 Max.	mW
		Ta = 85 °C, per pin	50 Max.	
Storage temperature	T_{STG}	–	-65 to +150	°C

1. Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions as detailed elsewhere in this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Operating Conditions

Parameter	Symbol	Conditions	Value	Unit
Digital power supply voltage	V_{DD}	f_{OSC} = 32 MHz	4.5 ~ 5.5	V
Analog power supply voltage	AV_{DD}	$V_{DD} = AV_{DD}$	4.5 ~ 5.5	
Analog reference voltage	V_{REF}		AV_{DD} -0.3 ~ AV_{DD}	
Analog input voltage	V_{AI}		A_{GND} ~ V_{REF}	
Storage holding voltage	V_{DDH}	f_{OSC} = 0 MHz	2.0 ~ 5.5	
Operating frequency	f_{OSC}	V_{DD} = 5 V ±10%	32	MHz
Ambient temperature	Ta	–	-40 ~ 70	°C
Fan-out	N	MOS load	20	
		TTL load, AD0 ~ AD7	3.2	mA
		TTL Load, all other outputs	1.6	mA

DC Characteristics (VDD = 4.5 ~ 5.5 V, Ta = -40 ~ 70 °C)

Parameter	Symbol	Condition	Rated Value			Unit
			Min	Typ [1]	Max	
High-level input voltage	V_{IH}	Applied to AD0-AD7	2.2	–	V_{DD} +0.3	V
		Applied to OSC0	0.85 x V_{DD}	–	V_{DD} + 0.3	
		Applied to all other I/O	0.80 x V_{DD}	–	V_{DD} + 0.3	
Low-level input voltage	V_{IL}	Applied to AD0-AD7	-0.3	–	0.8	
		Applied to OSC0	-0.3	–	0.15 x V_{DD}	
		Applied to all other I/O	-0.3	–	0.2 x V_{DD}	
High-level output voltage	V_{OH}	Output current = 400 µA, applied to AD0-AD7, ALE, and $\overline{ROMRD}$	V_{DD} -0.4	–	–	
		Output current = 200 µA, for all other I/O	V_{DD} -0.4	–	–	
Low-level output voltage	V_{OL}	Output current = 3.2 mA, applied to AD0-AD7, ALE, and $\overline{ROMRD}$	–	–	0.4	
		Output current = 1.6 mA, for all other I/O	–	–	0.4	
Input leak current	I_{IH}, I_{IL}	V_I = V_{DD}/0 V, applied to Ain, $\overline{EA}$, FLOAT, and RESTART	–	–	1/-1	µA
Input current		V_I = V_{DD}/0 V, applied to $\overline{RES}$	–	–	1/-250	
		V_I = V_{DD}/0 V, applied to OSC0	–	–	15/-15	
High-level output current	I_{OH}	V_O = 2.4 V, applied to AD0-AD7	-2	–	–	mA
		V_O = 2.4 V, applied to all other I/O	-1	–	–	
Low-level output current	I_{OL}	V_O = 2.4 V, applied to AD0-AD7	10	–	–	
		V_O = 2.4 V, applied to all other I/O	5	–	–	
Output leakage current	I_{LO}	V_O = V_{DD}/0 V		–	±2	µA
Input capacitance	C_I	f = 1 MHz, T_a = 25 °C	–	5	–	pF
Output capacitance	C_O		–	7	–	
Analog reference power supply voltage	I_{REF}	During voice input	–	–	4	mA
		When voice input is halted	–	–	10	µA
Power consumption in STOP mode	I_{DDS}	V_{DD} = 2 V, Ta = 25 °C	–	0.2	10	
		Ports for input pins are V_{DD} or GND, otherwise no load	–	1	100	
Power consumption in HALT mode	I_{DDH}	f_{OSC} = 32 MHz, no load	–	–	60	mA
Power consumption	I_{DD}		–	–	144	

1. Typical condition is 5 V 25 °C.

AC Characteristics

External Program Memory Control (VDD = 4.5 ~ 5.5 V, Ta = -40 ~ 70 °C)

Parameter	Symbol	Conditions	Min.	Max.	Unit
Clock pulse width (OSC)	t_{0W}	–	15.625	–	ns
ALE pulse width	t_{AW}	CL = 50 pF	$3t_{0W}$ -10	–	
$\overline{ROMRD}$ pulse width	t_{PW}		$4t_{0W}$ -10	–	
$\overline{ROMRD}$ pulse delay time	t_{PAD}		t_{0W} -5	t_{0W} +5	
Low address set-up time	t_{AAS}		$2t_{0W}$ -10	$2t_{0W}$ +10	
Low address hold time	t_{AAH}		t_{0W} -5	t_{0W} +5	
High address delay time	t_{AAD}		t_{0W}	t_{0W} +10	
High address hold time	t_{APH}		t_{0W}	t_{0W} +10	
Instruction set-up time	t_{IS}		35	–	
Instruction hold time	t_{IH}		0	t_{0W} +10	

External Data Memory Control (VDD = 4.5 ~ 5.5 V, Ta = -40 ~ 70 °C)

Parameter	Symbol	Conditions	Min.	Max.	Unit
Clock pulse width (OSC)	t_{0W}	–	15.625	–	ns
ALE pulse width	t_{AW}	C_L = 50 pF	$3t_{0W}$ -10	–	
$\overline{RDRAM}$ pulse width	t_{RW}		$4t_{0W}$ -10	–	
$\overline{WRRAM}$ pulse width	t_{WW}		$4t_{0W}$ -10	–	
$\overline{RDRAM}$ pulse delay time	t_{RAD}		t_{0W} -5	t_{0W} +5	
$\overline{WRRAM}$ pulse delay time	t_{WAD}		t_{0W} -5	t_{0W} +5	
Low address set-up time	t_{AAS}		$2t_{0W}$ -10	$2t_{0W}$ +10	
Low address hold time	t_{AAH}		t_{0W} -5	t_{0W} +5	
High address set-up time	t_{AAD}		t_{0W}	t_{0W} +10	
High address hold time	t_{ARH}, t_{AWH}		t_{0W}	t_{0W} +10	
Memory data set-up time	t_{MS}		35	–	
Memory data hold time	t_{MH}		0	t_{0W} - 10	
Data set-up time	t_{DD}		t_{0W}	t_{0W} +10	
Data hold time	t_{DH}		t_{0W}	t_{0W} +10	

Timing Diagrams

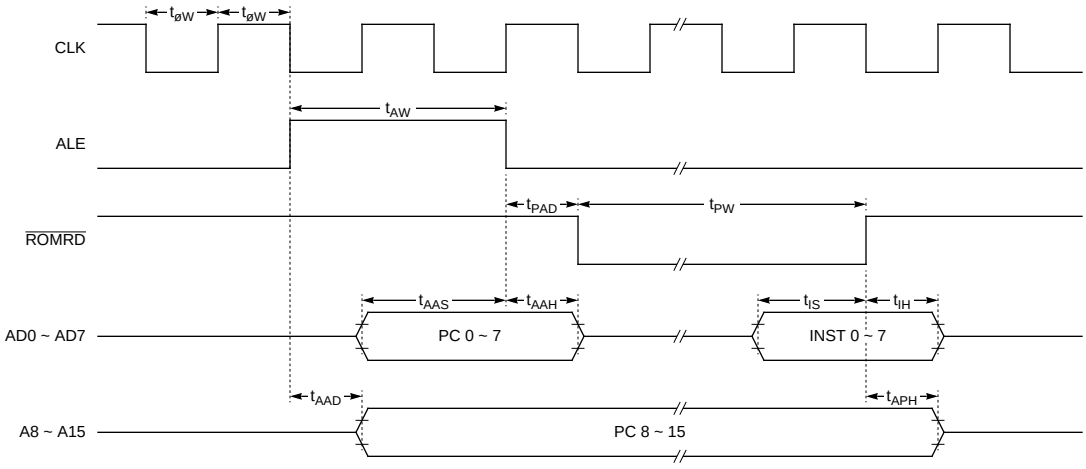

Figure 5. ROM Read Timing

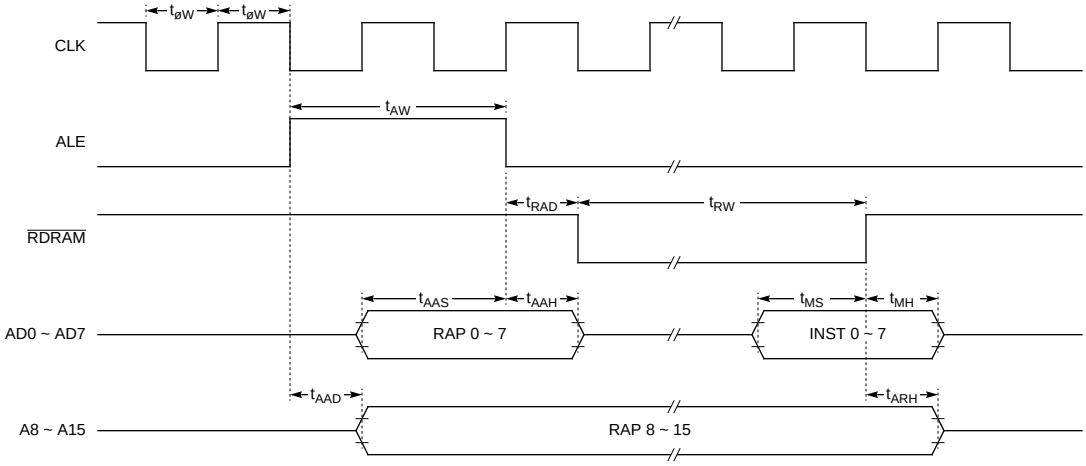

Figure 6. RAM Read Timing

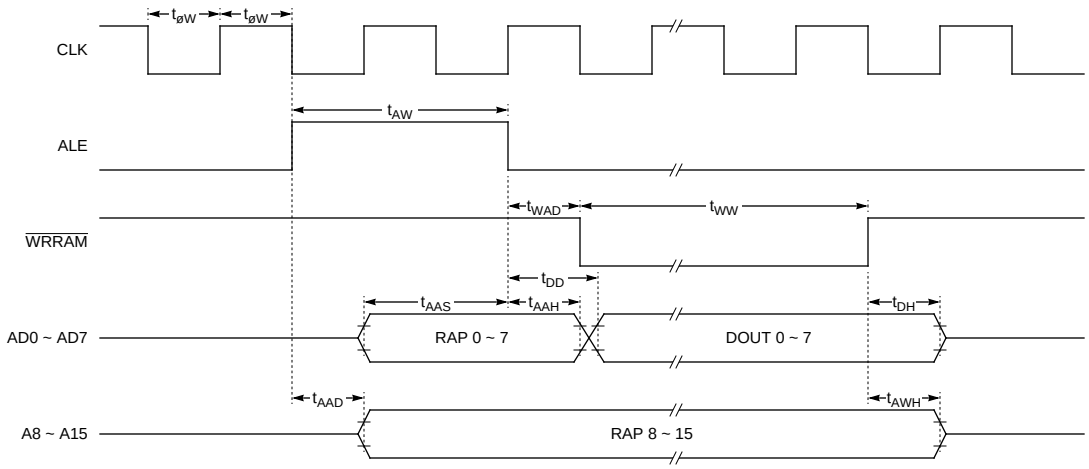

Figure 7. RAM Write Timing

FUNCTIONAL DESCRIPTION

Voice Recognition

The MSM6679 performs both *Speaker-Independent* (*SI*) and *Speaker-Dependent* (*SD*) recognition. SI vocabularies are embedded in the MSM6679. For SD recognition, each recognized phrase must be *enrolled* in the MSM6679's vocabulary by creating a *composite template* from multiple recordings of the same phrase, which is then stored in SRAM or FLASH memory. During both SI and SD recognition, the MSM6679 performs the following steps:

1. After external band-pass filtering, the MSM6679 converts the analog signal to PCM samples.
2. The MSM6679 extracts significant features from the sample data by frequency and time-domain analysis.
3. The MSM6679 compares the analyzed input with the reference data for each signal, weighing the significance of similarities according to control software parameters. A *score* (expressed as *distance*) is generated for each phrase.
4. The vocabulary phrase that achieves the highest score (or lowest distance) is judged to match the input phrase, assuming that the score exceeds a pre-determined threshold.
5. Via a special command, the MSM6679 can also return the scores of the input against all defined vocabulary phrases for SI or SD recognition. This allows external host software to select the next best match, if the closest match is not contextually logical.

SI Recognition

OKI supplies the MSM6679 with predefined SI vocabularies, which OKI builds from hundreds of utterances by a wide variety of speakers. SI vocabularies are limited to 25 words or less., which allows the MSM6679 to achieve a net accuracy of >95%, even in noisy conditions.

SI vocabularies are grouped into sub-vocabularies of ≤15 words, to maintain the highest accuracy. Similar words in any one sub-vocabulary can cause substitution errors.

OKI Semiconductor's standard cellular vocabulary is intended for an automotive environment with a far talk microphone. This vocabulary may work adequately in other conditions, such as an office or outside, but recognition performance may be degraded.

MSM6679 Cellular SI Recognition Vocabulary

Sub-Vocabulary 1		Sub-Vocabulary 2				Sub-Vocabulary 3	
Phrase	Index	Phrase	Index	Phrase	Index	Phrase	Index
Store	1	One	1	Seven	7	Yes	1
Dial	2	Two	2	Eight	8	No	2
Delete	3	Three	3	Nine	9	Cancel	3
Directory	4	Four	4	Zero	Ah		
		Five	5	Oh	Bh		
		Six	6	Stop	Ch		
				Clear	Dh		

SI vocabulary generation starts with collecting reference utterances from ≥400 speakers, with an equal mixture of males and females, with accents from all regions of the country of intended use, and with ~15% non-native speakers. The samples should be generated from a randomly-ordered list, with each word spoken twice and with a dummy word at the beginning and end. There must be >2sec between each sample for accurate data processing. To provide the audio fidelity required for high-quality recognition training, a DAT recorder, together with the microphone that will be used in the final application, is required. To ensure data integrity, data is submitted to OKI after collecting samples from the first 20 speakers for initial screening. If acceptable, then the remaining collection may proceed. If substitution errors are possible, collection of spare words during initial collection is recommended. For example, alternate words to "Stop" and "Top" could be "Halt" and "First."

Collections should contain a wide variety of the background sound conditions that will exist during actual usage. For example, if the collection is for use in an automobile, conditions such as vehicle speed, road conditions, various window opening positions, heater or AC blower speeds and radio volumes should be varied during the collection. The signal-to-noise ratio should be maintained at ≥20dB.

To achieve high accuracy rates, phrase selection, data collection, background initialization strategy, and control software need careful consideration. There are no published standards for recognition accuracy. OKI defines accuracy by:

$$\text{Accuracy} = 100\% - E_{RATE}$$

$$E_{RATE} = E_{SUB} + 1/2\ E_{REJ}$$

with the following definitions:

Parameters for Recognition Accuracy

Name	Symbol	Comments
Substitution Error	E_{SUB}	Most critical type error, e.g., Say "Five", recognize "Nine"
Rejection Error	E_{REJ}	Word not recognized, opportunity for operator to repeat
Gap Error	E_{GAP}	Word spoken before recognizer ready
Time-Out Error	E_{TIME}	Word length is two long
Spurious Response Error	E_{SPU}	Sound or invalid word classified as a valid word (i.e., drop handset or speak wrong word)

A typical target accuracy of 97% is achieved with a 3% E_{RATE}, composed of a 1.5% E_{SUB} rate and a 3% E_{REJ} rate.

SD Recognition

In SD recognition mode, the MSM6679 can be trained to recognize up to 61 words. The MSM6679 can support multiple speakers by switching vocabularies, but only one speaker's vocabulary should be active at one time.

The end user *enrolls* a phrase in the MSM6679's vocabulary by recording the phrase three times or more. The host MCU controls the number of times each phrase in enrolled. Generally, higher recognition accuracy is achieved with each additional enrollment. The word set is made more robust by pronouncing each phrase slightly differently during initial enrollment.

In addition to enrollment training, adaptive template updating can drive the accuracy towards 100%. The host MCU updates templates by first asking the speaker to confirm a recognized phrase with a "yes" or

"no" response, and subsequently updating the template for corresponding words. The use of name tags (see next paragraph) facilitates this process.

Name Tag Recording

To facilitate SD recognition, the MSM6679 supports recording and playback of name tags. Name tags are used to confirm correct responses in SD recognition. For example, in a phone dialer application, the user associates a "name," which is recorded into memory, with a phone number. The MSM6679 then plays back the name tag so that the user can verify that the recognized phrase is the correct one.

The VRP stores names tags in memory utilizing an ADPCM compression algorithm with 28K bits per second of speech. The length of a name tag is controlled with a command from the users host MCU program. The maximum number of name tags possible is 61, but the actual number is dependent upon record time and memory available. See the section on memory interface for more detail.

Audio Input Interface

A critical item for high-accuracy speech recognition is correct design of the audio input circuit. A circuit with appropriate gain and frequency responses must be placed between the microphone and MSM6679's A/D input. OKI recommends input gain and a band pass filter with the following characteristics:

- Four pole Chebyshev high-pass filter, 3dB point at 225Hz
- Dual-pole low-pass filter, 3dB point at 4250Hz
- Midband gain of 46dB at 1000Hz

The above gain and filter characteristics are obtained by using a rail-to-rail quad CMOS op-amp and one-half supply rail splitter to bias the input signal at 2.5 volts nominal.

The MSM6679 uses multiple analog inputs to improve sampling quality. An on-chip A/D conversion unit transforms the analog signal to a digital data stream.

Audio Output Interface

The MSM6679 also provides the VOICEOUT1 PWM output. The MSM6679 uses Adaptive Differential Pulse Code Modulation (ADPCM) to generate voice or sound-effect output. ADPCM represents an improvement over conventional PCM techniques in that it adaptively changes the quantizer step (scale factor) to suit the waveform being encoded. The result is more efficient memory utilization with no loss of quality.

It is recommended that the components for internal and external output filters and amplifiers be carefully selected. An incorrect choice would impair the original quality. This consideration equally includes the careful separation of analog and digital lines, the grounding of analog lines at both ends, and further adequate separation from high-speed digital circuits to avoid distortions thereof.

Memory Interface

The memory control section manages RAM and/or ROM devices in two 64-Kbyte memory spaces, in conjunction with internal memory for voice templates and working memory. Some versions work with no external memory, some have some external RAM, some use only external EPROM, and some use external memory in conjunction with both internal ROM and RAM. The MSM6679 requires a minimum of 32 Kbytes SRAM and 16 Kbytes ROM.

The following table shows vocabulary sizes and playback facilities for various configurations.

Typical Configurations

Application	Recognition Vocabulary (Words)		MSM6679 Sound Playback (sec) [1]		MSM665x Playback Interface	MSM6679 Speech Record	MSM6679 Speech Playback	Memory Size (bytes)		
	SI	SD	Internal	External				EPROM	Flash	SRAM
Controller	25	61 [2]	2.3	9.2	✓	—	✓	64K	—	32K
	50	61 [2]	2.3	—	✓	—	✓			
Telephone Dialer	25	61	2.3	27.6	✓	✓	✓	—	128K	32K
	50	61	2.3	18.4	✓	✓	✓			
	75	61	2.3	9.2	✓	✓	✓			
	100	61	2.3	—	✓	✓	✓			
Computer Peripheral	61 [3]	61	2.3	36.8	✓	—	✓	—	—	64 ~ 384K
Minimum Configuration	12	61 [2]	1.15		✓	—	—	16K	—	32K

1. Phrase chaining features usually permit much longer overall playback durations. Not including external speech synthesizer.
2. SD recognition vocabularies are volatile in these configurations.
3. Per download. Vocabulary swapping by host permits unlimited vocabulary size.

The MSM6679 supports up to 64 Kbytes of RAM per bank, and up to 64 Kbytes of ROM per bank in separate memory spaces. The 8-bit data bus is multiplexed with the lower eight address bits; the upper eight address bits are not multiplexed.

To demultiplex the address and data bits during all read and write cycles, the MSM6679 requires an external octal latch, such as the 74H373. The MSM6679's Address Latch Enable (ALE) signal controls the octal latch.

For accessing the ROM and RAM address spaces, the MSM6679 provides the separate Write RAM ($\overline{\text{WRRAM}}$), Read RAM ($\overline{\text{RDRAM}}$), and ROM Read ($\overline{\text{ROMRD}}$) signals. The $\overline{\text{RDRAM}}$ and $\overline{\text{ROMRD}}$ signals connect directly to Output Enable ($\overline{\text{OE}}$) control signal inputs on the RAM and ROM, respectively. The $\overline{\text{WRRAM}}$ signal connects directly to the Write Enable ($\overline{\text{WE}}$) control signal input on the RAM.

The following diagrams show the memory maps for the MSM6679. In all MSM6679 memory maps, the DL data memory space must be in RAM. The DH data memory space and PH program memory space can either be implemented in ROM, EPROM, FLASH, RAM, or PROM.

In standalone applications, flash memory can be used for recording and subsequent playback of voice prompts, such as the user's name, and user sounds, such as DTMF dial tones, etc.

Figure 8 shows the configuration for writing to flash memory, used when writing SD templates, or when flash is used for data memory.

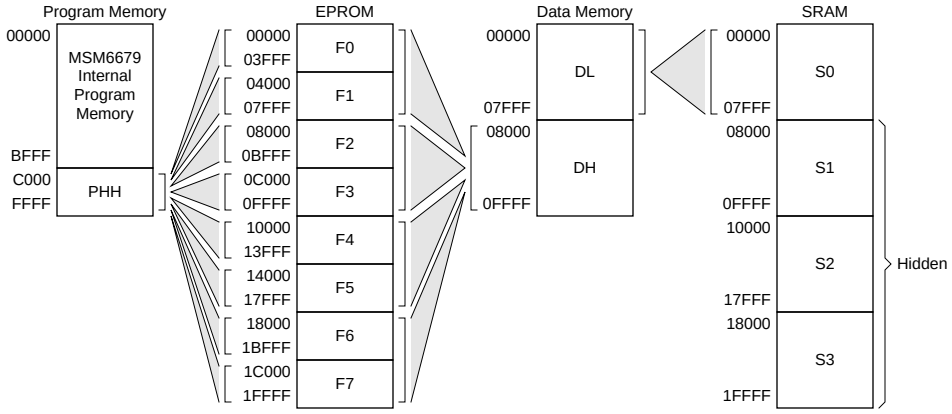

Figure 8. MSM6679 Program/Data Memory Map ($\overline{\text{LOADPGM}}$ = "0")

Figure 9 shows the memory map during all other modes of operation.

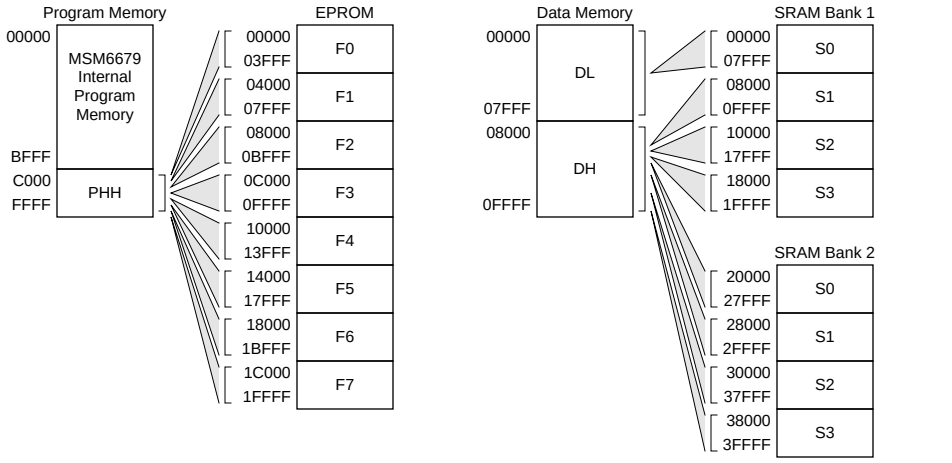

Figure 9. MSM6679 Program/Data Memory Map ($\overline{\text{LOADPGM}}$ = "1")

External Voice Synthesis Control

The MSM6679 is capable of interfacing to the MSM665x family of OKI ROM, OTP, or external EPROM speech synthesizers, allowing for up to 260 seconds of high-quality voice and sound effects. The following table indicates the speech capabilities of the MSM665x family.

MSM665x Family Characteristics.

Type	Data ROM Capacity [1]	Maximum Speech Duration [2]				
		f_{SAM} = 4.0 kHz	f_{SAM} = 6.4 kHz	f_{SAM} = 8.0 kHz	f_{SAM} = 16.0 kHz	f_{SAM} = 32.0 kHz
MSM6650	64 Mbits [3]	> 1 hour	> 40 minutes	> 30 minutes	> 15 minutes	> 8 minutes
MSM6652	288 Kbit	16.9 sec	10.5 sec	8.4 sec	4.2 sec	2.1 sec
MSM6653	544 Kbit	31.2 sec	19.5 sec	15.6 sec	7.8 sec	3.9 sec
MSM66P54 [4]	1 Mbit	63.8 sec	39.9 sec	31.9 sec	15.9 sec	7.9 sec
MSM6654	1 Mbit	63.8 sec	39.9 sec	31.9 sec	15.9 sec	7.9 sec
MSM6655	1.5 Mbit	96.5 sec	60.3 sec	48.2 sec	24.1 sec	12.0 sec
MSM6656	2 Mbit	129.1 sec	80.7 sec	64.5 sec	32.2 sec	16.1 sec

1. Actual ROM area in MSM6652, MSM6653, MSM6654, MSM6655, and MSM6656 is smaller by 22 Kbits.
2. Longer speech patterns can be created by chaining and repeating existing speech samples.
3. Via external ROM only (no on-chip ROM available).
4. One-Time-Programmable (OTP) version of MSM6654. See the MSM66P54 data sheet for more information.

The MSM665x interface consists of the following signals:

- $\overline{\text{BUSY}}$ – Asserted LOW during MSM665x device playback. The MSM6679 F50Bh and F10100xxh commands select this signal for MSM665x command polling.
- $\overline{\text{NAR}}$ – Next Address Request status signal. By default, the MSM6679 uses this signal to poll commands to the MSM665x. The F480h and F440h commands select NAR for polling.
- SI – Serial Input Clock.
- SD – Serial Data Out.
- $\overline{\text{STROBE}}$ – Initiates speech synthesis.
- $\overline{\text{RESOUT}}$ – Initializes device when asserted LOW. The MSM6679 F480h command generates this signal.

Serial Interface

The MSM6679 supplies a serial interface, suitable for connection to an RS-232C serial port buffer or equivalent. The serial interface uses one MSM6679 input (RXD) and one MSM6679 output (TXD). The interface operates at 9600 Baud with 8 data bits, 1 start bit, 1 stop bit, no parity, and no handshake.

A host processor sends serial ASCII commands to the MSM6679 and receives serial ASCII responses based on voice input responses.

Parallel Interface

A flexible parallel interface allows connection to many different types of host computer. The parallel interface includes the following components:

- SPD0-SPD7 connect through a 74F543 latch to the host system's data bus for parallel control, status and data transfer.
- RESTART, $\overline{\text{COMMAND}}$, $\overline{\text{READ}}$, $\overline{\text{SPRD}}$, $\overline{\text{SPWR}}$, RES , $\overline{\text{READCLR}}$, and $\overline{\text{CMNDCLR}}$ manage and handshake the interface.
- IRQSPCH, ISEL0, ISEL1, and $\overline{\text{IENABLE}}$ allow plug-and-play compatible host interruption and rerouting (external PAL required for decoding).

MSM6679 SLAVE-MODE API

This section describes the slave-mode Applications Protocol Interface (API) between a host MCU and the MSM6679. The slave-mode API offers the following features:

- Direct slave-mode control voice recognition, sound recording and playback, and sound synthesis
- Serial and parallel port interfaces
- Simple procedures for downloading and uploading data
- ASCII format
- Comprehensive return codes and error reporting

The host MCU selects the active speech recognition vocabulary, speech responses, and controls all actions required to implement an interactive voice response system. The MSM6679 performs speech recognition, based on the vocabulary selected by the host, and returns digital codes representing the most probable match of the current utterance to an individual utterance in the selected vocabulary. The MSM6679 can also respond with "name tags." Name tags can be fixed words, phrases or sound effects, or can be words, phrases or sound effects that have been interactively recorded by the user.

The API supports both serial and parallel interfaces. The MSM6679 returns each response using the same interface through which the most recent message was received. The user can thus connect and use both interfaces.

For all messages, the parallel interface uses 8-bit binary values, while the serial interface represents each 8-bit value with two hexadecimal digits coded in ASCII. When downloading and uploading data, the MSM6679 uses a stream of 8-bit binary values on both parallel and serial interfaces.

The serial-mode interface uses a 9600-baud UART with 1 start bit, 8 data bits, and 1 stop bit. There is no parity or handshaking. Serial-interface messages are of variable length, but consist of an even number of bytes. The serial interface echoes all received ASCII characters immediately back to the host MCU.

Messages are of variable length. All messages consist of an even number of bytes. Opcodes consist of exactly four bytes, with values between F000h and FEFEh. Operand bytes may take values from 0000h to FFFFh. The MSM6679 issues a return code for many of the host commands. The return code generally consists of the same opcode, followed by data indicating success of failure of the operation.

Opcodes are organized into the following categories:

- Purge
- Set parameter
- Initialize
- Recognize
- Speak
- Request
- Record
- SD recognition control

The following tables summarize available opcodes and provide detailed descriptions of the opcode functions.

Command Summary

Function	Opcode (Hex)	Description	Default (Hex)
Purge	F000	Clear MSM6679 input stack.	—
Set parameter	F102 xxxx	Set SP/SI origin to xxxx.	8000
	F103 xxxx	Set SD origin.	4A00
	F104 xxxx	Set triggering origin.	F100
	F11x	Set IRQ level to IRQ x.	0005
	F12x	Set SD SP table to table x.	F123
	F130 xxxx	Select triggering table.	0101, 0202...
	F440	Set ISA mode.	Disabled.
Initialize	F2xx mod 80	Initialize background estimation.	Disabled.
	F2xx mod 40	Wait for F3h command after each response.	Enabled.
	F2xx mod 20	Beep after each triggered utterance	Disabled.
	F2xx mod 10	Enable host IRQ generation (IRQ mode).	Enabled.
	F2xx mod 8	Set speech response level to default.	Enabled.
	F2xx mod 4	Send acknowledge after each speech output response.	Disabled.
	F2xx mod 2	Only detect triggers.	Disabled.
	F2xx mod 1	Initialize SD parameter table and name tags (follow this command with F50A).	Disabled.
Recognize	F300	Stop listening (recognition).	—
	F301 ~ F33F	Start SI recognition.	—
	F340	Start SD recognition.	—
	F341	Sort SD recognition distances, return index to utterance with least distance.	—
	F342	Update SD enrollment.	—
	F343	Request recognition parameter upload to host.	—
	F344	Sort SD recognition distances, return index and distance to utterance with least distance	—
	F351	Sort SD recognition distances, return all distances.	—
	F361	Sort SD recognition distances, return minimum and maximum energy values.	—
	F371	Sort SD recognition distances, return all energy values and distances.	
Speak	F401 ~ F43D	Play back name tag from external memory.	—
	F441 ~ F47C	Play back sound from internal memory.	—
	F47E	Play 50-ms beep.	—
	F47F	Pause for 0.2 seconds.	—
	F480	Initialize MSM665x IC, set MSM665x busy mode OFF, select ROM SI recognition.	—
	F481 ~ F4FF	Play back one of 127 phrases in external MSM665x device.	—
	F50B	Set MSM665x busy mode ON.	OFF
	FE00 ~ FEFE	Set output volume (00h = minimum, FEh = maximum).	FE80h
Request	F500	Status request.	—
	F501	Select last ROM bank for SI recognition.	F509
	F510	Select alternate bank for SI recognition.	F509
	F502....	Download/upload.	—
	F503 xxxx	Select/jump.	—
	F504	Retrieve MSM6679 firmware revision.	—
	F505	Initialize background (BG) noise level.	—
	F506	Retrieve vocabulary and trigger table revision number.	—
	F507	Save SD templates from RAM to FLASH.	—
	F508	Recall SD templates from FLASH to RAM.	—
	F509	Select first ROM bank for SI recognition.	F509
Record	F101 00xx	Set name tag length, set MSM665x busy mode ON.	0064
	F50A	Clear name tag table in SRAM (use after F2xx mod 1 command).	—
	F50C	Recall last saved name tag table.	—
	F50D	Save name tag table from SRAM to FLASH.	—
	F50E	Set record volume high.	F50F
	F50F	Set record volume normal (default).	F50F
	FA01 ~ FA3D	Record name tag 01h ~ 3Dh.	—

Function	Opcode (Hex)	Description	Default (Hex)
SD Recognition Control	F6xx	Set SD pointer to segment xxh.	—
	F9xx	Search for SD utterance xxh.	—
	FB00	Enroll SD utterance selected by search command (F9xx).	—
	FC00	Erase utterance from SD vocabulary.	—

Response Summary

Command	Operands	Description
Result after Parameter Set	F101h 00 tm F102h AdH AdL F103h AdH AdL F104h AdH AdL F11Xh F12Xh	Record time = tm*14 msec. High and low bytes of SP/SI origin address. High and low bytes of SD origin address. High and low bytes of triggering origin address. IRQ Xh selected. SP table Xh selected.
Initialization Acknowledgment	F280h F240h F220h F210h F208h F204h F202h F201h	Invalid message received. Sample data over-run. [1] 32-Kbyte block boundary violation error. Unclassified download/upload error. Divide-by-zero error. Select/jump error. Invalid SP header or table. Reserved.
Speech Ack	F400h	Speech acknowledgment. [2]
Status [3]	F500h F501h F520h F540h F560h F580h F5A0h F5C0h F5E0h F5F0h	MSM6679 ready. Background initialization complete. Operations complete; MSM6679 disabled (vocabulary 0). MSM6679 waiting for start command. MSM6679 waiting for end trigger. MSM6679 processing recognition. Download/upload in progress. [4] Download/upload complete. Select/Jump complete. Speak output in progress.
SI Recognition Result [5]	F600h F60Xh Utt F61Xh Utt Dst1H Dst1L...DstNH DstNL F62Xh Utt EminH EminL EmaxH EmaxL F63Xh Utt Dst1H Dst1L...DstNH DstNL EminH EminL EmaxH EmaxL F63Ah F63Bh F63Ch F63Dh F63Eh F63Fh	Aborting SI listen mode. Xh = vocabulary#, Utt = utterance ID. Vocabulary#, utterance ID, high/low byte of distance to utterance 1...utterance N. Vocabulary#, utterance ID, high/low byte of min. and max. energy value, Vocabulary#, utterance ID, high/low byte of distance to utterance 1...utterance N, high/low byte of minimum energy value, high/low byte of maximum energy value. Trigger detection code (see init command). Rejection: utterance too loud. Rejection: utterance too long. Rejection: utterance begins too soon. Rejection: bad signal/noise ratio. Rejection: reason uncertain.
SD Recognition Result	F700h F73Eh F73Fh F740h F341h Utt F344h Utt DstH DstL F351h Utt Dst1H Dst1L...DstNH DstNL F361h Utt EminH EminL EmaxH EmaxL F371h Utt Dst1H Dst1L...DstNH DstNL EminH EminL EmaxH EmaxL	Aborting SD Listen mode. After SD utterance search: not found. Rejection. Sort completed. After SD utterance search: empty. Rejection: MSM6679 SD memory full/empty. After SD utterance search: in use. Utt = Utterance ID triggered. Utterance ID, high/low byte of distance. Utterance ID, high/low byte of distance to utterance 1...utterance N. Utterance ID, high/low byte of minimum energy value, maximum energy value. Utterance ID, high and low byte of distance to utterance 1...distance to utterance N, high and low byte of minimum energy value, maximum energy value.
Vector Upload	F743h 0000h F743h NH NL V1H V1L...VNH VNL	Upload failure. High/low bytes of length of vector, V, high/low byte of first V...Nth V.

Response Summary (Continued)

Command	Operands	Description
Trap Error Codes	F801h	Reserved.
	F802h	Invalid SP header or table.
	F804h	Select/jump error.
	F808h	Divide-by-zero error.
	F810h	Unclassified download/upload error.
	F820h	Memory full; 32-Kbyte block boundary violation error.
	F840h	Sample data over-run. [1]
	F880h	Invalid message received.
Record Response	FA00	Record complete.

1. Sample data over-run issued when real-time SP in Listen mode cannot keep up with incoming samples, i.e., if the A/D signal input routine overwrites a sample data buffer before it is fully processed.
2. This acknowledge is sent only if Init command F204h is set to enable acknowledgments.
3. These messages are sent in response to a request command (F5XYh) from the host.
4. Upload/download in progress, acknowledging load request immediately before data transfer. If in response to an N-byte download request, the MSM6679 then receives N bytes (if N is even, or N+1 if N is odd) of data from the host. If N is odd and N+1 bytes are received, only N bytes are written to MSM6679 memory. If in response to an upload, the MSM6679 then sends N bytes (if N is even, or N+1 if N is odd) of data to the host.
5. If an utterance was recognized, XYh is the utterance identity or class number, and additional parameters may be appended, if requested in the SI Recog (F3XYh with X=0...3) command. Otherwise, XYh indicates various results as detailed.

Command Descriptions

Purge

Operand	Description	Return Values
F000	**Purge MSM6679 Input Stack.** This command clears the MSM6679 input stack of commands that are waiting to be executed. Commands already in progress, such as a pending MSM6654 poll action, are not affected. It does not affect the MSM6679 output stack.	None

Set Parameter

Operand	Description	Return Values [1]
F102h XXYYh	**Set SP/SI Recognition Origin.** Prior to SD or SI recognition, address pointers must be set to point at the signal processing (SP) or SI recognition parameter tables.This command sets the starting address of signal processing (SP) and SI recognition parameter tables. This address is the location of the first word of a header that contains pointers to one or more individual SP/SI tables. XXYYh = High (XXh) and low (YYh) bytes of requested address. The MSM6679 uses and returns an even address outside the MSM6679 work space that is as near as possible to the requested address. Leave this parameter at its default value unless you are using an OKI custom SI vocabulary and are instructed to alter SP/SI recognition origin. Default SP/SI origin: 8000h	F102h XXYYh = High (XXh) and low (YYh) bytes of resultant address. If a valid header is not found at the resultant address, the MSM6679 sends an additional message: F802h = Invalid SP/SI header.
F103h XXYYh	**Set SD Recognition Origin.** This command sets the SD origin address at the starting address of the current SD recognition parameter table. This command may be used to select among multiple RAM-resident SD vocabulary tables. XXYYh = High (XXh) and low (YYh) bytes of requested address. The MSM6679 uses and returns an even address outside the MSM6679 work space that is as near as possible to the requested address. Leave this parameter at its default value unless you are using an OKI custom vocabulary and are instructed to alter SD recognition origin. Default SD origin: 4A00h	F103h XXYYh = High (XXh) and low (YYh) of resultant address.
F104h XXYYh	**Set Triggering Origin**. This command sets the starting address of triggering parameter tables. This address is the location of the first word of a section of data memory containing one or more contiguous triggering parameter tables. XXYYh = High (XXh) and low (YYh) bytes of requested address. The MSM6679 uses and returns an even address outside the MSM6679 work space that is as near as possible to the requested address. Leave this parameter at its default value unless you are using an OKI custom SI vocabulary and are instructed to alter triggering origin. Default triggering origin: F100h.	F104h XXYYh = High (XXh) and low (YYh) bytes of resultant address.
F11Yh	**Set IRQ Level.** This command requests direction of host interrupts to IRQ Y. The MSM6679 then selects IRQ Z, where Z is the nearest legal value to Y. Legal IRQ values are any from the set {5 (default),A,B,C}. Default IRQ level: 5	F11Zh = IRQ Z selected.

Set Parameter (Continued)

Operand	Description	Return Values [1]
F12Yh	**Set SD Recognition SP Table.** This command sets the signal processing (SP) parameter table number to be used in processing speech input during SD Recognition. The MSM6679 selects SP table number Z, where Z is the nearest valid value to Y. By default, the MSM6679 selects SP table 3 until this command is issued. This command selects SP parameters only, and does not select among multiple RAM-resident SD vocabulary tables, which are independently selected by the Set SD Origin command (F103h). After setting the table number and returning the resultant value, the MSM6679 checks the validity of the SP header. If the header is invalid, an error message is returned. Set this value to (NSI +1), where NSI is the number of SI subvocabularies. Default SP table: 3.	F12Z = SP table Z selected. If the SP header is invalid, a second message follows: F802h = Invalid SP header.
F130h VN TN	**Select Triggering Table.** This command selects triggering table TN for use with SP table VN. Valid values for VN and TN are between 01h and 0Fh. Leave this parameter at its default value unless you are using an OKI custom SI vocabulary and are instructed to alter the triggering table.	F130h f(VN) f(TN) = Triggering table selected. Default = 0101, 0202, 0303...
F440h	**Set ISA Mode**. This command sets the port configuration for the ISA bus.	None.

1. Return value is actual parameter value, which may not equal the set parameter value.

Initialize

F2xx Bit Values	Power-On/ Reset Value	Action	Return Value
After power-on, the MSM6679's mode corresponds to that after issuing a F258h command. This mode is likely to NOT be the optimum condition for most situations, so the user is advised to carefully understand the desired condition and develop a suitable command for the application at hand. In addition, ensure that unwanted bits do not get reset when attempting to set individual conditions. The conditions selected are based on the XXh values associated with the last F2 command issued.			
1xxx xxxx	Cleared	**Background Noise Initialization.** When set to 1, the MSM6679 starts a 500-ms background noise initialization. When set to 0, the MSM6679 does not perform background noise initialization. The MSM6679 requires this command prior to recognition for noise vector subtraction during the utterance sampling period. Use the background initialization command whenever there is a change in the background noise level. For example, sample the noise signature in a vehicle at rest and moving at 35 MPH with its windows rolled down. The quality of a phone line connection can also vary from call to call. The host MCU must implement a strategy as to when to issue a background initialization command. In a vehicle, the host MCU could monitor the vehicle speed, fan speed, radio volume, etc. Alternatively, the host MCU could issue this command each time a new recognition session starts or a new line connection is established. However, the 0.5sec sample period could degrade system responsiveness if used too frequently. A zero in this bit location during the F2XXh command will not cause an initialization. The F505h command causes the same initialization sequence.	F501 = Background initialization complete F2XY = Initialization acknowledge. [1]
x1xx xxxx	Set	**Wait for Recognition Command/Auto Restart SI Recognition.** When set to 1, the MSM6679 waits for a recognition command after each response. When set to 0, the MSM6679 auto-restarts SI recognition after each response. This bit should be set to 1 when an action is to be taken immediately after an utterance. Auto-restart recognition is the desired mode during digit string recognition, automated tape testing of digits, or in demonstrations where continuous recognition is desired.	F2XY = Initialization acknowledge. [1]

Initialize (Continued)

F2xx Bit Values	Power-On/ Reset Value	Action	Return Value
xx1x xxxx	Cleared	**Beep After Each Voice Trigger.** When set to 1, the MSM6679 beeps after each voice trigger. When set to 0, the MSM6679 does not beep after each voice trigger. These beeps do not cause a F400h message to be issued to the host MCU. When set to 1, the MSM6679 beep can prevent a user from speaking before the MSM6679 is ready. This mode is normally used with a digits vocabulary to pace the user and confirm that utterance reception. Instead of using beeps, an external MSM665x speech synthesizer can repeat digits as they are recognized. However, some users find the number repetition annoying. Firmware could therefore repeat digits during initial usage and switch to beep mode later. Typically, performance improves with time as users learns to speak with the correct enunciation and volumes. The MSM6679 in this case trains the user. Note that the host MCU can also make the MSM6679 beep with the F47Eh command.	F2XY = Initialization acknowledge. [1]
xxx1 xxxx	Set	**Enable ISA interrupt request (IRQ)**. When set to 1, the MSM6679 generates an interrupt after each read or write to the parallel interface. When set to 0, the MSM6679 does not generate an interrupt after each read or write to the parallel interface.	F2XY = Initialization acknowledge. [1]
xxxx 1xxx	Set	**Set Output Volume.** When set to 1, VOICEOUT1 sound output level is set to half of full volume (80h). When set to 0, voice output level is unaffected. MSM6679 sound output volume can also be set at any level on a continuous scale from 00h to FEh (low to high) with the FEXXh command. The MSM665x speech synthesizer has four discrete sound output volumes, corresponding to 0h ~ 20h, 21h ~ 40h, 41h ~ 80h, and 81h ~ FEh.	F2XY = Initialization acknowledge. [1]
xxxx x1xx	Cleared	**Send Response Code After Sound Output.** When set to 1, the MSM6679 issues an acknowledge response (F400h) when sound output is completed. When set to 0, the MSM6679 does not issue an acknowledge response when speech response is completed. Automatic beeps after voice triggers do not cause an F400h command to be issued.	F2XY = Initialization acknowledge. [1]
xxxx xx1x	Cleared	**Trigger Detection Only**. When set to 1, the MSM6679 does not sort SI vocabularies for the best match, instead returning F63Ah code when an utterance has been detected. When set to 0, normal recognition is performed. When this bit is set to 1, the host MCU can use the F343h command to upload the recognition parameter vector, so that the host can perform independent processing.	F2XY = Initialization acknowledge. [1]
xxxx xxx1	Cleared	**Clear SD Recognition and Name Tag RAM.** When set to 1, the MSM6679 initializes the SD parameter table. When set to 0, existing SD parameters are preserved. After this bit is set to 1, all SD training and name tag pointers are erased. Use this command to start training for a new user. If the old name tags are to be retained, the F50Ch command can recall old name tags from FLASH; otherwise, issue the F50A command to set up a blank name tag table. To set up for a blank SD and name tag table at the next power-on, issue the command sequence F201h F50Ah F50Dh F507h.	F2XY = Initialization acknowledge. [1]

1. See the Response Summary table earlier in this section for a complete description of the XY codes in initialization acknowledgment messages.

Recognize

Opcode	Action	Return Value	
F300h	**Stop Listening**. This command causes the MSM6679 to exit SI or SD Listen mode, whichever was active.	None	MSM6679 was not in Listen mode.
		F600h	Aborting SI Listen mode.
		F700h	Aborting SD Listen mode.

Recognize (Continued)

Opcode	Action		Return Value	
F301h ~ F33Fh	**Start SI Listen Mode**. For all the following opcodes, the MSM6679 performs SI recognition on incoming utterances, using SI vocabulary Y. The vocabulary Y is identified by one of 15 sets, thus Y = 1h ~ Fh.		F600h	Aborting SI Listen mode.
			F63Ah	Trigger detection code (see Initialization command).
			F63Bh ~ F63Fh	Rejection.
			F802h	Invalid signal processing table.
			F840h	Sample data overrun.
	F30Yh	Return recognized phrase using vocabulary number Y.	F6h Utt	Utterance ID in vocabulary Y.
	F31Yh	Return recognized phrase and distance table for vocab Y	F6h Utt Dst1H Dst1L... DstNH DstNL	Utterance ID in vocabulary Y, high and low byte of distance to utterance 1...distance to utterance N.
	F32Yh	Return recognized phrase and energy value for vocab Y.	F6h Utt EminH EminL EmaxH EmaxL	Utterance ID in vocabulary Y, high and low byte of minimum and maximum energy value.
	F33Yh	Return recognized phrase, distance table, and energy value for vocab Y	F6h Utt Dst1H Dst1L... DstNH DstNL EminH EminL EmaxH EmaxL	Utterance ID, high and low byte of distance to utterance 1...distance to utterance N, high and low byte of minimum and maximum energy value.
F340h	**Start SD Listen Mode**. When an utterance is captured, it is analyzed and converted to a "recognition parameter vector." The host may then command the MSM6679 to use this vector in various ways (e.g., Sort, Update, or Recognition Vector Upload).		F740	Triggered.
			F700	Abort SD Listen mode.
			F73B ~ F73E	Rejection.
			F73F	Memory empty.
			F802	Invalid SP table.
			F840	Sample data overrun.
F341h, F344h, F351h, F361h, F371h	**SD Recognition Sort**. These commands sort the distances between the recognition parameter vector and the reference vectors for the utterances in the current SD vocabulary.		F73Fh	Abnormal response: Memory empty.
	F341h	Return recognized phrase for vocab Y. This command can be issued several times to yield first, second, third best, etc.	F7h Utt	Utt= Utterance ID.
	F344h	Return recognized phrase and distance for the current vocabulary.	F7h Utt DstH DstL	Utt = index of recognized phrase, DstH DstL = high/low bytes of distance from nearest phrase.
	F351	Return recognized phrase and distance table for vocab Y.	F7h Utt Dst1H Dst1L... DstNH DstNL	Utterance ID, high and low byte of distance to utt. 1...N.
	F361h	Return recognized phrase and energy value for vocab Y.	F7h Utt EminH EminL EmaxH EmaxL	Utterance ID, high and low byte of minimum and maximum energy value.
	F371h	Return recognized phrase, distance table, and energy value for vocab Y.	F7h Utt Dst1H Dst1L... DstNH DstNL EminH EminL EmaxH EmaxL	Utterance ID, high and low byte of distance to utterance 1...distance to utterance N, high and low byte of minimum and maximum energy value.

Recognize (Continued)

Opcode	Action	Return Value	
F342h	**Update SD Recognition Enrollment.** This command updates enrollment on utterance Utt, immediately after a "F7h Utt" response to the Sort SD Distances command (F341h). Alternatively, the utterance to be updated can be selected by the SD Search command (F9XYh). This command uses the recognition parameter vector from the most recently captured utterance, and does not start SD Listen mode. Generally, update should be performed only if correct utterance identify is confirmed by the user.	F740h	Update complete.
F343h	**Recognition Vector Upload.** Request recognition parameter vector upload to host.	F743h NH NL V1H V1L... VNH VNL = Success, where NH/NL = High/low bytes of N, N = Length of recognition parameter vector V, V1H/V1L = High/low bytes of first element of V, VNH/VNL = High/low bytes of Nth element.	
		F743h 00 00	Failure.

Speak

Opcode	Action		Return Value	
F401h ~ F43Dh	**Speak Phrase from External Memory**. This command causes the MSM6679 to play back a name tag from external memory. If no sound is defined for a selected index, the MSM6679 plays a beep. See the Record commands for information on creating name tags.		F400h	If enabled, this value is returned upon completion of playback.
F441h ~ F450h	**Speak Phrase from Low Internal Memory**. If no sound is defined for a selected index, the MSM6679 plays a beep. The default phrases supplied with the MSM6679 in the smaller low playback memory area are listed below.		F400h	If enabled, this value is returned upon completion of playback.
	F441h	Drip.		
	F442h	Buzzer.		
	F443h	Dial tone.		
	F444h	Bonk.		
F451h ~ F47Ch	**Speak Phrase from High Internal/External Memory**. If no sound is defined for a selected index, the MSM6679 plays a beep. The default phrases supplied with the MSM6679 in the larger upper playback memory area are listed below.		F400h	If enabled, this value is returned upon completion of playback.
	F451h	"0" simulated DTMF tone.		
	F452h	"1" simulated DTMF tone.		
	F453h	"2" simulated DTMF tone.		
	F454h	"3" simulated DTMF tone.		
	F455h	"4" simulated DTMF tone.		
	F456h	"5" simulated DTMF tone.		
	F457h	"6" simulated DTMF tone.		
	F458h	"7" simulated DTMF tone.		
	F459h	"8" simulated DTMF tone.		
	F45Ah	"9" simulated DTMF tone.		
	F45Bh	"*" simulated DTMF tone.		
	F45Ch	"#" simulated DTMF tone.		
F47D	**Reserved**. This command is reserved for future use.		—	—

Speak (Continued)

Opcode	Action		Return Value	
F47Eh	**Beep**. This causes the MSM6679 to beep for 50ms.		F400h	If enabled, this value is returned upon completion of playback.
F47Fh	**Pause**. This command can be issued while the MSM6679 is performing sound output and is then put in the MSM6679 command stack for subsequent processing. When this command is executed, sound output pauses for 0.2 second. The pause command is useful for word spacing.		F400h	If enabled, this value is returned upon completion of playback.
F480h	**Set MSM6654 Mode**. This command causes the MSM6679 to initialize the external MSM665x device, also clearing the device from BUSY mode.		None.	
F481h ~ F4FFh	**Playback Sound from MSM665x Device**.This command causes the MSM6679 to issue a speak command to the MSM665x slave device. The value is passed on the MSM665x device as 01h ~ 07Fh. The actual phrase is determined by the vocabulary programmed into the MSM665x device. Up to 127 external phrases are supported.		F400h	If enabled, this value is returned upon completion of playback. If normal mode is set, the F400h command is sent when the MSM665x device is ready for another command.
F50Bh	**Set MSM665x Busy Mode ON.**		None.	
FEXYh	**Set Output Level**. This command sets the speech output level to one of 255 values as follows:		None.	
	FE00h	Set minimum output level.		
	FE80h	Set output level half way (default).		
	FEFEh	Set maximum output level.		

Request

Opcode	Action	Return Value	
F500h	**Status Request.** This command causes the MSM6679 to return a two-byte value indicating its current status.	F500h	MSM6679 ready.
		F520h	MSM6679 disabled.
		F540h	MSM6679 waiting for start.
		F560h	MSM6679 waiting for end.
		F580h	MSM6679 processing.
		F5A0h	Download/upload in progress.
		F5C0h	Download/upload complete.
		F5E0h	Select/jump complete.

Request (Continued)

<table>
<tr><th>Opcode</th><th colspan="3">Action</th><th colspan="2">Return Value</th></tr>
<tr><td rowspan="9">F503h Ctl Seg</td><td colspan="3">Select/Jump. This command selects a new data segment, or Jumps to a new program segment.
Ctl(7)=0 is used to first select a new data segment. Ctl(7)=1 then jumps to that program segment.</td><td colspan="2"></td></tr>
<tr><td rowspan="4">Ctl(7)=0</td><td>Seg(7)=0</td><td>Upper 32-Kbyte of selected segment is accessed normally.</td><td>F5E0h</td><td>Success.</td></tr>
<tr><td>Seg(7)=1</td><td>Access lower 32-Kbyte block of selected segment in upper 32 Kbytes of data space.</td><td rowspan="3">F8XYh</td><td rowspan="3">Failure, with XY(2) = 1.</td></tr>
<tr><td>Seg(6 ~ 2)</td><td>Reserved.</td></tr>
<tr><td>Seg(1 ~ 0)</td><td>Data segment selection.</td></tr>
<tr><td rowspan="4">Ctl(7) =1</td><td>Seg(7)=0</td><td>Jump to selected external program segment.</td><td rowspan="4">F5E0h</td><td rowspan="4">Success.</td></tr>
<tr><td>Seg(7)=1</td><td>Jump to internal program segment.</td></tr>
<tr><td>Seg(6 ~1)</td><td>Reserved.</td></tr>
<tr><td>Seg(0)</td><td>If Seg(7) =1, not used.
If Seg(7) = 0 and Seg(0) = 0: external program segment 0.
If Seg(7) = 0 and Seg(0) = 1: external program segment 1.</td><td>F8XYh</td><td>Failure, with XY(2) = 1.</td></tr>
<tr><td rowspan="14">F502h</td><td colspan="3" rowspan="14">Download/Upload.
Full syntax: F5 02 00 Ctl AdH AdL NH NL [Dt1... DtN [Dt(N+1)]]
Full syntax: F5 02 00 Ctl AdH AdL NH NL [Dt1... DtN [Dt(N+1)]]
Ctl(7) = 0 for download, Ctl(7) = 1 for upload
Ctl(6) = 0 for data RAM, Ctl(6) = 1 for program RAM/ROM
If Ctl(6)=0 then Ctl(1-0) = Seg: Data segment selection
If Ctl(6)=1 and Ctl(1-0) = x0, then external program segment 0 is used.
If Ctl(6)=1 and Ctl(1-0) = x1, then external program segment 1 is used.
AdH AdL = high, low bytes of starting address. NH NL = high, low bytes of N
N = Number of bytes to be downloaded or uploaded
Dt1... DtN = Download data. Note (here and in upload response) that data are 8-bit binary values, even if using the serial interface.
Dt(N+1). If N is odd, an extra byte is appended to the data so that the total number of bytes in the message remains even.
This command requests data transfer to/from data or external program memory.The control parameter (Ctl) controls the direction of the transfer (i.e., download vs. upload) and specifies which of six 64-Kbyte memory segments (i.e., four data segments and two external program segments) is to be accessed. This command does not work with internal program memory.
It is not possible to download to external program memory while running in external program memory. The address and length parameters (AdH AdL NH NL) specify the starting address and length of the transfer in bytes. Since the MSM6679 can only perform download/upload transfers within one 32-Kbyte block in one Download/Upload command, the address and length parameters must not specify a transfer that violates a 32-Kbyte address boundary. If this restriction is violated, the download/upload request will be denied.</td><td colspan="2">Immediately after receiving parameter NL, the MSM6679 responds with a message to indicate acceptance or denial of the transfer request. Acceptance is indicated by F5A0h. Denial is indicated by a F8XYh.

At the end of an accepted transfer, the MSM6679 responds with a message to confirm or deny valid completion of the transfer. Valid completion is indicated by F5C0h.</td></tr>
<tr><td>F880h</td><td>Invalid message received.</td></tr>
<tr><td>F840h</td><td>Sample data over-run.</td></tr>
<tr><td>F820h</td><td>32-Kbyte block boundary violation error.</td></tr>
<tr><td>F810h</td><td>Unclassified download/upload error.</td></tr>
<tr><td>F808h</td><td>Divide-by-zero error.</td></tr>
<tr><td>F804h</td><td>Select/jump error.</td></tr>
<tr><td>F802h</td><td>Invalid SP header or table.</td></tr>
<tr><td>F801h</td><td>Reserved.</td></tr>
<tr><td>FAXYh</td><td rowspan="2">Most and least significant byte of address where error occurred.</td></tr>
<tr><td>FBXYh</td></tr>
<tr><td>F504h</td><td colspan="3">Retrieve MSM6679 Firmware Revision Number.</td><td>XXXX</td><td>Four-digit ASCII number.</td></tr>
</table>

Request (Continued)

Opcode	Action	Return Value	
F505h	**Initialize in Background**. Background noise initialization is performed for 500 ms. The MSM6679 requires this command prior to recognition for noise vector subtraction during the utterance sampling period. Use the background initialization command whenever there is a change in the background noise level. For example, sample the noise signature in a vehicle at rest and moving at 35 MPH with its windows rolled down. The quality of a phone line connection can also vary from call to call. The host MCU must implement a strategy as to when to issue a background initialization command. In a vehicle, the host MCU could monitor the vehicle speed, fan speed, radio volume, etc. Alternatively, the host MCU could issue this command each time a new recognition session starts or a new line connection is established. However, the 0.5sec sample period could degrade system responsiveness if used too frequently. A zero in this bit location during the F2XXh command will not cause an initialization. The F2xxh command can also be used to perform background noise initialization.	F501h	Initialization is complete.
F506h	**Retrieve Vocabulary and Trigger Table Revision Number**.	XXXX	Four digit ASCII number.
F507h	**Save SD Templates**. SD recognition templates are written from RAM to EPROM.	F501h	Save is complete.
F508h	**Recall SD Template**s. SD recognition templates are written from EPROM to RAM.	F501h	Recall is complete.
F509h	**Select Default SI Vocabulary**.	27	27
F501h	**Select Last Bank for SI Recognition.**		
F510h	**Select Alternate Bank for SI Recognition.**		

Record

Opcode	Action	Return Value	
F101h 00XXh	**Set Name Tag Length, Set MSM665x Busy Mode ON**. Name tag record length is set by XXh, with XXh defining record length in 14-ms intervals. The maximum record length of FFh yields a recording interval of 3.57 seconds. The default value is 1.4 seconds.	F101h 00XXh	Operation complete.
F50Ah	**Clear Name Tag Table**.	F501h	Name tag table cleared.
F50Ch	**Recall Last Saved Name Tag Table**.	F501h	Last saved name tag table recalled.
F50Dh	**Save Name Tag Table**.	F501h	Name tag table saved.
F50Eh	**Set Record Volume High**.	—	—
F50Fh	**Set Record Volume to Normal.** This is the default setting.	—	—
FA00h	**Reserved**. This command is reserved for future use.	—	—
FA01h ~ FA3Dh	**Record Name Tag.**	FA00h	Completed.
		F280h	Memory full.
FA3Dh ~ FAFFh	**Reserved**. These commands are reserved for future use.	—	—

SD Recognition Control

Opcode	Operation	Return Value	
Recognition performance is largely a function of how well the enrollment data represents subsequent tokens of the enrolled utterances, and performance generally improves steadily with each additional enrollment pass. For most applications, three initial enrollment passes are recommended. Subsequent reference updating can be performed with the SD Recognize Update command (F342).			
F6XYh	**Set SD Segment Pointer**. This command sets the SD segment pointer to XY00h, i.e., set the starting address of the current SD recognition parameter table to XY00h. Issuing this command is equivalent to issuing the Set SD Origin command, F103h XY00h. For further details of operation, please refer to the description of that command.	No return value.	
F9XYh	**Search for SD Utterance XY**. This is the first step in adding an utterance to the vocabulary, or in replacing an existing one. The SD vocabulary memory is searched for utt. no. XYh. If it is not found, and if sufficient SD memory exists, the MSM6679 prepares to add utterance number XYh to the vocabulary.	F740h	Utterance number found.
		F700h	Utterance number not found.
		F73Fh	Memory full.
FB00h	**Enroll SD Utterance.** This command starts MSM6679 SD Listen mode, then uses the next captured utterance to start or update training of the reference data for SD utterance number XY specified in the most recent Search command (F9XYh). The user must be prompted to say the utterance prior to issuing this command. If the utterance was previously enrolled, a training update is performed; if not, the reference data is initialized. Each utterance in the SD vocabulary must be enrolled at least once before it can be recognized.	F740h	Operation complete.
		F700h	Aborting SD Listen mode.
		F73Eh	Improper level, must repeat.
		F802h	Invalid signal processing table.
		F840h	Sample data overrun.
FC00h	**Erase utterance from SD vocabulary.** This command erases the reference parameters for utterance number XYh from the SD vocabulary, where XYh is the utterance number retained from the previous Search command (F9XYh).	F740h	Operation complete.

Asynchronous Serial Protocol Example

All messages to the MSM6679 (except downloads and uploads) are echoed, but replies from the MSM6679 to the host are not echoed by the host. This facilitates manual communication with the MSM6679 using standard terminals.The following example illustrates the range of MSM6679 functions.

Comment	Action	Voice Input	Host Command	MSM6679 Response
Initialize MSM6679	Host initializes MSM6679.		F258	F258
	MSM6679 acknowledges.			F200
Install New Software Version	Host requests download		F502	F502
	to program segment 40,		0040	0040
	starting at location 0,		0000	0000
	of 32k bytes (8000h).		8000	8000
	MSM6679 accepts request.			F5A0
	Host sends 32k bytes. (~34 sec at 9600 baud)		...	
	MSM6679 indicates download complete.			F5C0
Upload Software for Verification of Transfer	Host requests upload		F502	F502
	from program segment 0,		00C0	00C0
	starting at location 0,		0000	0000
	of 32k bytes (8000h).		8000	8000
	MSM6679 accepts request.			F5A0
	MSM6679 sends 32k bytes.			...
	MSM6679 indicates upload complete.			F5C0
Run New Software	Host commands jump		F503	F503
	to external program segment 0.		8000	8000
	MSM6679 begins running new load.			F5E0
Load Trigger Tables at 5000h	Host requests download		F502	F502
	to data segment 0,		0000	0000
	starting at location 5000h,		5000	5000
	of 256 bytes (0100h).		0100	0100
	MSM6679 accepts request.			F5A0
	Host sends 256 bytes (~0.25 seconds at 9600 baud).		...	
	MSM6679 indicates download complete.			F5C0
Set New Triggering Origin	Host requests		F104	F104
	Set triggering origin to 5000h.		5000	5000
	MSM6679 sets triggering origin			F104
	and sends confirming response.			5000
Download New SD Vocabulary	Host requests download		F502	F502
	to data segment 0,		0000	0000
	starting at location 6000h,		6000	6000
	of 4k bytes (1000h).		1000	1000
	MSM6679 accepts request.			F5A0
	Host sends 4k bytes (~4.3 seconds at 9600 baud)		...	
	MSM6679 indicates download complete.			F5C0

Comment	Action	Voice Input	Host Command	MSM6679 Response
Set new SD tables	Host requests		F103	F103
	Set SD origin to 6000h.		6000	6000
	MSM6679 sets SD origin			F103
	and responds.			6000
Download First 4K of SI Vocabulary	Host requests download		F502	F502
	to data segment 0,		0000	0000
	starting at location 7000h,		7000	7000
	of 4k bytes (1000h).		1000	1000
	MSM6679 accepts request.			F5A0
	Host sends 4k bytes.		...	
	MSM6679 indicates download complete.			F5C0
Download Last 32K of SI Vocabulary	Host requests download		F502	F502
	to data segment 0,		0000	0000
	starting at location 8000h,		8000	8000
	of 32k bytes (8000h).		8000	8000
	MSM6679 accepts request			F5A0
	HOST sends 32k bytes.		...	
	MSM6679 indicates download complete.			F5C0
Set New SP/SI Tables	Host requests		F102	F102
	Set SP/SI origin = 7000h.		7000	7000
	MSM6679 sets SP/SI origin			F102
	and responds.			7000
Upload Data for Diagnostics	Host requests upload		F502	F502
	from data segment 0,		00A0	00A0
	starting at location 300h,		0300	0300
	of 45 bytes (2Dh).		002D	002D
	MSM6679 accepts request, signals in progress.			F5A0
	MSM6679 sends 46 bytes.			...
	MSM6679 indicates upload complete.			F5C0
Set up MSM6679 for SI Recognition	Host requests set SP table 3.		F123	F123
	MSM6679 selects SP table 3 and confirms.			F123
	Host initializes MSM6679.		F258	F258
	MSM6679 acknowledges.			F200
SI Recognition	Host starts SI recognition, vocabulary 1.		F301	F301
		"Dial"		
	MSM6679 recognizes utterance #3.			F603
	Host starts SI recognition, vocabulary 2.		F302	F302
		"Two"		
	MSM6679 recognizes utterance #2.			F602
	Host starts SI recognition, vocabulary 2.		F302	F302
		"Three"		
	MSM6679 recognizes utterance #3.			F603

Comment	Action	Voice Input	Host Command	MSM6679 Response
SD Enrollment	Host starts SI recognition, vocabulary 1.		F301	F301
		"Store"		
	MSM6679 recognizes utterance #7.			F607
	Get ready to train SD utterance #1.		F901	F901
	Memory is empty and ready to train.			F700
	Pass 1; host sends SD enroll command.		FB00	FB00
		"John Smith"		
	SD utterance #1 initialized.			F740
	Pass 2; host sends SD enroll command.		FB00	FB00
		"John Smith"		
	SD utterance #1 updated.			F740
	Pass 3. Host sends SD enroll command.		FB00	FB00
		"John Smith"		
	SD utterance # 1 updated.			F740
SI Recognition of Control Words	Host starts SI recognition, vocabulary 1.		F301	F301
		"Dial"		
	MSM6679 recognizes utterance #3.			F603
	Host starts SI recognition, vocabulary 2.		F302	F302
		"Five"		
	MSM6679 recognizes utterance #5.			F605
	Host starts SI recognition, vocabulary 2.		F302	F302
		"Six"		
	MSM6679 recognizes utterance #6.			F606
	Host starts SI recognition, vocabulary 1.		F301	F301
		"Store"		
	MSM6679 recognizes utterance #7.			F607
SD Enrollment	Host prepares MSM6679 to train SD utterance #2		F902	F902
	Memory is empty and ready to train.			F700
	Pass 1; host sends SD enroll command.		FB00	FB00
		"Bill Jones"		
	SD utterance # 2 initialized.			F740
	Pass 2; host sends SD enroll command.		FB00	FB00
		"Bill Jones"		
	MSM6679 updates SD utterance # 2.			F740
	Pass 3; host sends SD enroll command.		FB00	FB00
		"Bill Jones"		
	MSM6679 signals operation completed.			F740
SI Recognition of Control Word	Host starts SI recognition, Vocabulary 1.		F301	F301
		"Call"		
	MSM6679 recognizes utterance #11.			F60B
SD Recognition.	Host starts SD recognition.		F340	F340
		"John Smith"		

Comment	Action	Voice Input	Host Command	MSM6679 Response
	MSM6679 signals trigger OK.			F740
	Host sends SD sort command.		F341	F341
	MSM6679 recognizes utterance 1.			F701
Name Tag Recording	Host initiates MSM665x port.		F480	F480
	Host sets recording length to 1 sec		F101 0047	F101 0047
	MSM6679 signals operation complete.			F101 0047
	Host clears name tag table		F50A	F50A
	MSM6679 signals operation complete.			F501
	Host sets record gain to max. level.		F50E	F50E
	Start recording tag one.		FA01	FA01
		"Jane Doe"		
	MSM6679 signals name tag recording complete.			FA00
	Save name tags to FLASH.		F50D	F50D
	Name tags saved.			F501
Name Tag Playback	Host sets volume to max. level.		FEFF	FEFF
	Host commands play back name tag 1.		F401	F401
				"Jane Doe"
	MSM6679 signals playback OK.			F400
Sound Playback	Host sets output volume to mid point.		FE80	FE80
	Play MSM6679 internal sound #1		F442	F442
				"bzzzz"
	Play back sound from MSM6654		F49F	F49F
				"Completed"